Chemical weathering rates viewed from the twin perspectives of soils and surface waters

JAMES W. KIRCHNER[123*] AND CLIFFORD S. RIEBE[4]

[1]Dept. of Environmental System Sciences, ETH Zurich, Switzerland (*correspondence: kirchner@ethz.ch)
[2]Swiss Federal Research Institute WSL, Switzerland
[3]Dept. Earth and Planetary Science, U. Calif., Berkeley, CA, USA
[4]Dept. Geology & Geophysics, U. Wyoming, WY, USA

Chemical weathering rates are conventionally inferred from field data in one of two ways. The first is the catchment mass balance approach, in which one calculates weathering rates by subtracting the chemical fluxes in atmospheric deposition from those in streamflow. This method typically yields weathering rate estimates over years or decades, limited by the length of the chemical time series. The second method is the soil mass balance approach, in which one calculates weathering rates from the depletion of mobile elements relative to immobile elements in a soil profile of known age (or of known steady-state erosion rate). This method averages weathering rates over the age of the soil, typically thousands of years or more. These two methods embody different assumptions and intrinsically average erosion rates over different timescales, and it is unclear whether they give consistent results.

To find out, we compared decade-scale mass balances for three small catchments at Silver Creek, Idaho [1] with long-term soil mass balances using cosmogenic nuclide methods [2]. The short-term catchment mass balances are consistent with the long-term soil mass balances for some elements but not for others. The discrepancies can potentially arise from the different time scales, from differences between the two methods, or from the geochemical behavior of the solutes as they move through the hillslope-channel continuum. Alternative hypotheses for the observed patterns in weathering rates will be presented, evaluated, and discussed.

[1] Clayton & Megahan (1986) *Earth Surf. Procs. and Landforms,* **11**, 389-400.
[1] Granger and Riebe (2014) *Treatise on Geochemistry*, 2nd ed., **7**, 401-436.